AN OBSERVATION ON ECOLOGY OF *Stephanitis typica* DISTANT (HEMIPTERA, TINGIDAE) ON BANANA

By

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INTRODUCTION

Banana lace bug, *Stephanitis typica* Distant, which were originally described in Ceylan in 1903. In 1914, it was first recorded in this inland. Later, Takahashi (1936), Shiraki (1937) and others etc. reported that this bug mainly attacked languas (*Alpinia galanga*, Zingibraces) in Taiwan; whereas it feeded on banana and other plants in the southern part of China, Java and India. Subsequently, this bug was recognized to be a pest of banana in this island by Miwa (1943).

Since 1963, the bug has been found to be aboundant on banana orchard and caused a serious damage by its infestation in Chia-yi and Kaohsung districts. In the following years, it rapidly distributed to every banana plantation throughout this island. Under requiring, a test of chemical control was carried out by Chein & Huang (1965). The present study was conducted during the years of 1965 to 1966 to investigate some ecological aspects of this bug that might be helpful to field control of this pest.

MATERIALS AND METHODS

Life history study: This study was carried out near our laboratory where thirty banana-plants were grown for rearing of lace bug. One portion of a banana leaf on each plant was caged with wire-cage of 25 cm in each side. A pair of freshly emerged adults were then placed in this cage. After the adults oviposited readily in the tissues of banana leaf, then they were removed to the another cage for determination of their longevity and the fecundity of female adult. On the other hand, as the nymph hatched, they were transferred individually to another cage for the investigation of the duration of each stage and survival rate. Twenty five pairs of lace bugs were observed in each generation.

Field observation: This observation includes habits, seasonal succession, proportion of sexes, distribution and naturl enemies of this bug. Two banana orchards were chosen for this study, one was at Chiayi Agricultural Experiment Station, the other was in the suburb of Chiayi. On each of banana orchard, forty plants were marked for the observation, and each leaf of plants was taken three parts and each was 10 cm in length for sampling (Fig. 1). The survey was by means of counting the number of the insect pest per sampling part on each leaf

of a plant. The various damages by this pest on each banana variety, on different height of banana-plant were also noted in this study. All the available data were recorded and analyzed statistically.

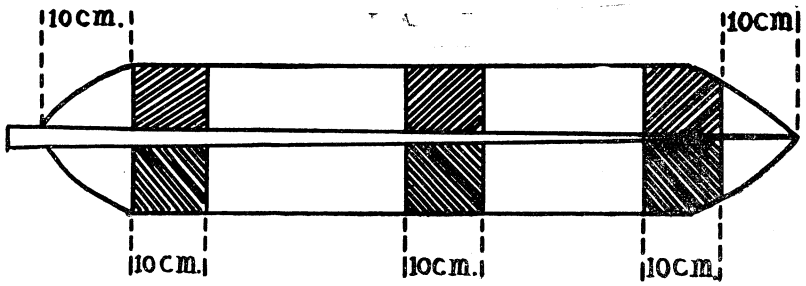

Fig. 1. Banana leaf showing the sampling parts for an investigation of lace bug population

Natural enemy study: This study was performed in the laboratory for investigating the life history, feeding behavior and feeding capacity of the predator. The adult of predators were collected from the field and confined individually in the glass tube, 3 cm in diameter and 13 cm in height, containing a section of banana leaf infested with lace bugs. The predators oviposited readily in the tissues of a leaf, then the leaves with eggs were removed daily and placed into another glass tubes. As the nymph hatched, they were transferred individually to another tube contaning a section of banana leaf infested with the lace bugs. The leaves with preys were renewed daily, and the duration of each stage and the number of lace bugs preyed were also recorded.

In the whole period of observations, the climatic data at Chiayi Agriculutral Experiment Station were also recorded.

RESULTS AND DISCUSSION

1. Character of injury

Both adults and nymphs infest plants by sucking the sap from the underside of the leaves. This withdrawal of plant juice causes the leaves become mottled with grayish-yellow blotches which, when aboundant, result in complete blanching.

The lower sufface of infested leaves is discolored by numerous flattered, black, shinym molasses-like spots of excrement. Its ecdysis may be seen adhering to the underside of the leaves until the leaves wilted. Badly damaged plant would wilt early, and then retarded the growth of plant at last.

2. Life history

The banana lace bug was known to have 9 generations from July 1965 to July 1966 in this area, Eight stages: egg, five instars and adult were found in a life-cycle. Data of the interval of each stage and generation were shown in Table 1.

Table 1. Records of observation on the life history of *Stephanitis typica* Distant on banana from July, 1965 to July, 1966

No. of gener.	Date conduct	Mean temp.	Preovip. (days)	Duration (Days)						
				Egg	Nymph (Inatar)					One lifecycle
					1st	2nd	3rd	4th	5th	
	1965									
6	20/7-10/8	27.95	3.54	8.70	2.36	2.10	2.22	2.56	3.29	24.36
7	16/8-10/9	27.27	5.63	13.45	2.33	2.33	1.62	2.10	3.14	30.20
8	20/9-19/10	26.75	6.72	11.91	3.00	2.55	2.52	3.24	4.06	34.20
9	22/10-3/12	23.44	7.36	13.67	4.36	3.05	2.55	2.98	6.24	40.88
1	12/12-19/2	18.56	9.87	31.45	6.90	5.90	6.25	6.00	6.20	73.72
	1966									
2	24/2-6/4	21.99	4.13	16.37	4.58	4.43	4.00	3.93	4.64	44.06
3	13/4-17/5	26.03	3.02	13.40	3.60	3.40	2.93	4.93	3.60	35.22
4	23/5-25/6	26.18	3.17	11.38	3.75	3.13	2.75	2.58	3.75	31.55
5	27/6-23/7		3.46	9.39	2.30	2.22	2.09	1.87	4.91	26.20
Average			5.21	14.30	3.69	3.23	2.99	3.35	4.43	37.82

The egg, which is approximately 0.39 mm. in length, 0.12 mm. in width, is like a pearl in color, but smooth, ovoid-clliptical and with a cap at the top end. The eggs were deposited in cluster in the tissues of banana leaf, and on each egg's cap where was covered with an excrement immediately after the egg has been deposited. The duration of the incubation period varied with the temperature. Observation (Table 2) indicated that the mininum time required for its incubation was 7 days at the average temperature 28.53°C; while at 17.10±0.23°C, it lasted 23.10±0.59 days in average.

Table 2. Effect of temperature on incubation of egg

Mean Temp. (°C)	Incubation of egg (Days)		
	Maximum	Minimum	Average
17.30±0.23	33	29	32.10±0.59
22.19±0.34	20	16	17.75±1.39
25.24±0.34	16	11	14.08±1.62
26.07±0.21	16	10	14.04±1.09
26.47±0.89	14	11	12.67±1.07
28.06±0.38	16	7	11.92±2.43

The newly-hatched nymph, average 0.68 mm. in length and 0.31 mm. in width, is yellowish-white in color. After they sucked the sap from plant, the color of head, end of antenna and abdomen change into brown. They generally got together and lived on the underside of a leaf, they also crawled short distance from where they were hatched or molted but never migrated from a leaf to another, excepting the leaves were wilted. In the nymphal stage, it molted 4 times. When they took the first step for molting, the insects standed with two

pairs of final leg, it lasted 4 hours to 12 hours and then emerged from the caronal suture. The wing-bud and paranotun was found to develope in th third instar, and especially noticeable in the fourth and fifth instar. The length of the nymphal stage was about 12 day in summer, and about one month in winter. The relation between the temperature and duration of nymphal stage were presented in Table 4. The survival rate of nymphal stage in each generation ranged from 59.86 to 88.24 per cent with an average of 71.16 per cent in the field (Table 5); while they were protected against the natural enemies attack, the survival rate nearly reached to 100 per cent.

Table 3. Characteristics on external feature of *Stephanitls typica* Distant

Stage	Body length (mm.)	Body width (mm.)	Color	Other
Egg	0.39	0.12	Pearl in color	Ovoid-ellipticul, with an cap at the top end.
1st instar	0.64	0.31	Head brown, other yellowish white	Paranotum undevelopment, without wing-buds.
2nd instar	0.93	0.43	5th segment of antenna, head, abdomen brown; other yellowish white.	Similar to 1st instar.
3rd instar	1.19	0.53	Similiar to 2nd instar.	Wing-buds and paranotum start to develop.
4th instar	1.53	0.68	Similiar to 2nd instar.	Wing-buds reach to 2nd segment of abdoment, paranotum develop.
5th instar	2.21	0.93	Both end of wing-buds slight brown, other similar to 2nd instar.	Wing-buds reach to 5th segment of abdoment, Parantum very development.
Adult female	2.14 3.36*	1.15 2.0 *	Wings have two brownish spots, body heavy brown.	With a pair of full-growth wing, head with hood, paranotum with median and lateral carian. The end of abdomen like V in form.
Adult male	2.20 3.43*	0.85 2.10*	Similiar to female	All similar to female excepting the end of abdomen like U in form.

The asterisk is shown the length or width with wings.

Table 4. Effect of temperature on the length of nymphal stage

Mean temp (°C)	Duration (Days)		
	Maximum	Manimum	Average
20.26±0.28	38	29	33.10±2.96
21.96±0.59	26	23	24.00±1.73
22.26±0.14	25	20	22.83±1.64
23.20±0.08	24	20	21.40±1.69
25.64±0.03	21	16	18.79±2.07
26.22±0.05	17	15	16.50±0.17
27.63±0.07	16	15	14.88±2.06
28.18±0.03	13	10	12.00±1.05

Table 5. Survival rate of *Stephanitiss typica* Distant

No. of gener. obs.	Mean temp. (°C)	No. of colonies obs.	No. of nymphs hatching	No. of adults appear.	Survivor per cent
6	27.95	10	83	50	60.24
7	27.27	17	64	84	75.00
8	26.75	27	238	210	88.24
9	23.44	35	183	115	62.84
1	18.56	15	142	85	59.86
2	21.99	10	91	62	68.13

The newly-emerged adult is white with a pair lace-like wings. After 2-3 hours, the body changed into heavy-brown in color. It was difficult to find their flying freely except they were disturbed or when they felt the places for oviposition. Although the flying capacity of this insect was very poor, but if they lean upon the help of the wind, they could be distributed to a great distance. Mating process usually accomplished in 1-2 days after the last molt of the female. As they were mating, the male and female were at an angle from 45 to 80. The mating act lasted from 50 seconds to 4 hours, and may be repeated.

Longevity of Adult: The longevity of adult was found to vary with the season, when the newly emerged adult was reared in the wire-cage containing a portion of a banana leaf, it took 11 to 73 days with an average of 31.44 days in male and 33.8 days in female during the cold season (18-20°C); while it took 2 days to 19 days with an average of 6.48 days in male and 7.1 days in female in summer, 1966 (27-30°C). However, the newly emerged or old adults were placed in the glass tube, 3 cm in diameter, 10 cm in length, with or without food, they only lived 2-3 days.

Proportion of sexes: In order to determine the sex ratio of the lace bug, the adults were collected every other days in September 1966, from a banana plantation in the suburb of Chiayi, and examined in laboratory with a low-power binocular microscope. The results were summarized in Table 6.

Here the sex ratio appeared to be slightly different, the number of the males were more than that of the females at the beginning of emerged period. Thereafter the famales were more than the males. It was possible that the males developed more quickly and lived shorter than females. The overall sex ratio in the entire period of 17 days was approximately 3:2.

Fecundity of the female: Thirty pairs of adults were observed in this study, each pair of newly emerged adults were placed in a wire-cage, 20 cm in each side, containing a portion of growing banana leaf. Observation was made daily till all the insect was dead. The results indicated that the number of eggs laying by each female adult was 36.8 in average, ranged from 0 to 71 in the period from January to Feburary, 1966. Another test took place in the period of July to August 1966, and adult laid 0 to 55 eggs with an average of 31.75. However

in these two tests, many adults died within 3 to 5 days after they were caged in the wire-cage, therefore the fecundity of a female was probably more than that has been shown in our study.

Table 6. The sex ratio of *Stephanistis typica* Distant

Date of obs.	No. of obs.	Sexiratio		Note
		Female	Male	
Sept.				
4	158	46.20	53.80	At the beginning of emergence
7	586	45.95	54.10	At one-third of emergence
9	765	53.69	41.31	At the maximum emergence
11	433	67.90	32.10	At the end of emergence
13	539	65.20	34.80	At the period of 1st to and instar
15	597	75.21	24.79	At the period of 2nd to 3rd instar
17	443	73.82	26.18	At the period of 3rd to 4th instar
19	195	62.05	37.95	At the period of 4th to 5th instar
21	373	60.05	39.95	At the period of 5th instar
Average		62.53	37.42	

Length of life-cycle: The life-cycle was determined as the interval from the parent adult to the appearance of next adult generation. From the data presenting in Table 1, the minimum period from the parent adult to the next generation adult was found in the 6th generation, which averaged 24.36 days, and ranged from 17 days to 26 days; while the maximum period was found in the 1st generation, it lasted 73.72 days in average, ranged from 69 days to 80 days. Total of 9 generations, the average duration of a life-cycle was found to be 34.82 days.

FIELD OBSERVATION

1. Observation on the location of eggs laid and number eggs in each egg-mass: The eggs of lace bug were laid together in the tissues of banana leaf. Generally an egg-mass was laid by a female adult, but it was found that two or more adults oviposited their eggs together in the period of high population density. However, a few adult females were found to lay their eggs in more than one place when they were disturbed in the midst of oviposition. It is easy to distinguish where the eggs were laid by many irregularly arranged excrements, which were used to cover on the top of the eggs.

In the period from August to September, 1966, the egg-masses on 10 banana plants were measured and collected from fields, and examined under low-power binocular microscope in the laboratory. The location of egg-mass on each leaf or a plant and the number of eggs were determined. The results were presented in Table 7 to 8 respestively.

Table 7. Location of egg-mass on a banana leaf

Distance from midrib (cm.)	Apical part		Middle part		Basal part	
	No. of eggs	percentage	No. of eggs	percentage	No. of eggs	percentage
0–10	290	90.91	219	63.85	327	72.51
10–20	29	9.09	124	36.15	123	27.27
Over 20	0	0	0	0	1	0.22
Total	310		343		451	
Percentage	28.66		30.82		40.52	

Table 8. Location of egg-mass on each leaf of a banana-plant

Leaf order	Number of banana-plant observated											
	1	2	3	4	5	6	7	8	9	10	Total	Percentage
1	0	0	0	0	0	0	0	0	0	0	0	0
2	1	8	1	4	1	1	5	1	6	2	30	7.91
3	9	21	6	15	13	27	7	4	12	11	125	32.93
4	11	24	12	15	8	18	11	12	3	16	130	34.30
5	0	9	10	8	8	11	8	11	0	7	72	19.00
6	1	2	—	1	1	—	3	2	1	1	12	3.17
7	—	3	—	1	2	—	1	—	2	1	10	2.64

From the data of Table 7 and Table 8, it indicated that lace bug laid their egg-mass mostly on the 3rd and 4th leaves in a plant and about 67.28 per cent out of the total located in that place. The egg-mass was scarcely found to lay on the newly grown leaf. The old leaves which had been deposited a great number of eggmasses by lace bugs before the last generation were not a preferential place for oviposition.

As a leaf was transversely divided into three part; namely basal part, middle part and apical part, then about 40.52% of egg-masses was laid on the basal part, another 30.82 per cent of egg-mass laid on the middle part of leaf, and only a few egg-masses was laid on the apical part. On the other hand, if the leaf was based on the midrib and perpendicularly divided into three parts of each side, then about 72.71 per cent of egg-mass was found to be laid on the place within 10 cm from midrib. The range from 10 cm to 20 cm away from the midrib was laid only 27.27 per cent, and the marginal zone was rarely laid.

The number of eggs containing in an egg-mass was quite uneven. The data indicated that the most egg-masses contained 10 to 15 eggs. The lowest number of eggs in an egg-mass was 1; the highest was 232; the average number of eggs of 589 egg-masses was 33.93.

2. The distribution of lace bug in a banana orchard: In order to determine the distribution of lace bug in a banana orchard, the number of adults and nym-

phs on each sampling place of a plant were counted and recorded. The results revealed that there were more lace bugs settling on the banana plants of 1-2 m. in height than those below 1 m. or over 2 m. in height, except in the period of adults in their maximum emergence. Generally, most adults would fly to the leaves of apical part for oviposition after they were emerged from nymphal stage, so that, at that time the population on the higher plant was higher than those on the lower one. It was especially noticeable on the plants of wind-sheltered plots. While, on those of no sheltered plots, the adults population on the plant of 1-2 m. in height was higher because the upper leaves would be blown to pieces (See Table 9-11).

Table 9. Distribution of *Stephanitis typica* on different height of Banana-plants in 1966

Date of obs.		Height of plant						Total
		Over 2 m.		1--2 m.		Below 1 m.		
		No. of bugs	Percentage	No. of bugs	Percentage	No. of bugs	Percentage	
Jan.	7	6.39	31.14	10.05	49.98	4.08	19.88	20.52
March	23	61.71	69.37	22.72	25.54	4.55	5.09	88.96*
June	26	18.65	32.97	20.35	35.98	17.56	31.05	56.16
Sept.	24	8.09	8.88	70.43	77.30	12.59	13.82	91.11

The asterisk is shown the adults in their maximum emergence.

Table 10. Distribution of *Stephanitis typica* on various part leaves of banana plants

Date of obs.		The leaves of upper part		The leaves of middle part		The leaves of low part		Total
		No. of bugs on the sampling place of a leaf	Percentage	No. of bugs on the sampling place of a leaf	Percentage	No. of bugs on the sampling place of a leaf	Percentage	
1965				Adult				
Apr.	15	2.65	40.90	2.37	36.57	1.46	22.53	6.48
May	19	7.04	63.03	2.90	25.96	1.23	11.01	11.17*
	29	13.63	66.75	5.57	27.28	1.22	5.97	20.42*
June	24	1.21	50.63	0.67	28.03	0.51	21.34	2.39
July	7	11.56	47.06	8.04	32.74	4.96	20.20	24.56*
	19	4.91	50.00	3.26	33.20	1.65	16.80	9.82
Aug.	2	2.15	37.99	2.00	35.34	1.51	26.68	5.66
	16	4.45	41.55	3.95	33.52	8.67	24.93	10.71*
Sept.	1	1.69	31.47	0.93	17.32	2.75	51.21	5.37
	14	10.35	40.91	9.91	39.17	5.04	19.92	25.30*
Oct.	1	1.60	44.69	1.27	35.47	0.71	19.83	3.58
	15	6.55	20.20	20.74	63.43	5.42	16.55	32.71*
Nov.	1	1.59	18.01	4.39	49.66	2.86	32.33	8.84
	16	4.00	56.74	2.12	30.07	0.93	13.19	7.05
Dec.	3	65.44	51.26	28.21	22.96	34.01	25.78	127.66*
	18	20.53	29.03	33.47	47.33	16.71	23.64	70.71

1966								
Jan.	1	5.77	34.22	7.93	47.03	3.16	18.74	16.86
	14	1.86	8.86	10.85	51.69	8.28	39.44	20.99
Feb.	1	3.93	39.30	3.43	34.30	2.63	26.40	10.00
	14	4.95	20.30	12.41	50.88	7.03	28.82	24.49
Mar.	1	38.58	76.61	6.09	12.09	5.69	11.30	50.56*
	15	16.91	40.67	19.99	48.08	4.68	11.25	41.58
Apr.	2	14.43	28.30	22.83	44.77	13.73	26.93	50.98
	15	16.39	20.28	40.00	59.25	11.12	16.47	67.51*
Total		263.17	40.02	252.97	38.61	139.97	21.37	655.11
1965				Nymph				
Apr.	15	0.39	1.95	11.08	55.26	8.58	42.79	20.05
May	19	21.33	19.44	65.27	57.50	23.10	21.06	109.70
	29	2.34	11.56	14.15	69.91	3.75	18.53	20.24
June	24	5.68	5.76	9.60	81.29	1.53	12.95	11.81
July	7	8.31	30.27	16.07	58.52	3.08	11.22	27.46
	19	10.91	33.24	20.42	62.22	1.49	4.54	32.82
Aug.	2	1.29	3.84	27.96	83.29	4.32	12.87	33.57
	16	1.55	9.90	12.98	83.00	1.11	7.09	15.65
Sept.	1	0.61	1.10	44.71	80.39	10.32	18.54	55.64
	14	1.20	5.21	17.69	76.85	4.13	17.94	23.02
Oct.	1	2.72	7.16	27.40	72.11	7.88	20.73	38.00
	15	2.96	6.42	39.16	84.89	4.01	8.69	46.13
Nov.	1	0.07	6.24	1.01	90.01	0.04	3.57	1.12
	16	6.56	5.95	55.87	50.68	47.82	43.37	110.25
Dec.	3	3.10	17.03	14.98	82.31	0.12	0.66	18.20
	18	1.98	5.71	22.21	64.08	10.47	30.21	34.66
1966								
Jun.	1	0.01	0.19	1.61	30.67	3.63	59.14	5.25
	14	0	0	11.68	41.26	16.63	58.74	28.31
Feb.	1	3.72	11.29	12.91	39.18	16.32	49.53	32.95
	14	1.61	2.17	51.96	69.98	20.68	27.85	74.25
Mar.	1	3.15	30.11	7.28	69.50	0.03	0.29	10.46
	15	6.68	13.26	33.55	66.61	10.14	20.13	50.37
Apr.	2	7.28	3.34	167.73	76.90	42.93	19.70	217.94
	15	6.99	3.83	157.25	86.25	18.07	9.92	182.31
Average		95.44	7.95	844.54	70,37	260.18	21.68	1200.16

The asterisk is shown the adults in their maximum emergence.

Another investigation was used to determine the distribution of lace bug on a banana plant throughout the year. The plants of 1-2 m. in height were used for investigation and then the leaves of each plant were divided into three parts: Upper part leaves (From 2nd to 4th leaf in order), Middle part leaves (From 5th to 7th leaf), and low part leaves (Below 7th leaves). The number of bugs of on each part was recorded twice a month. The results were shown in Table 10. The data clearly showed that during the period of warm season, the most adults were actively on the upper part's leaves, especially on the 2nd and third leaf, but most of the colonies of nymph settled on the middle part's leaves. During the cold season, it was found that the most adults changed to live on the middle part leaves, and nymphs settled on the lowest part's leaves. It seems the longevity of adults and the duration of a life-cycle were longer in cold season

than in warm season; therefore, the upper or middle part's leaves which originally colonized by the most of adults or nymphs were changed into the middle or lowest part's leaves owing to the newly grown leaves. Cold and severe wind might be an another factor that forced the insects to live on the lower leaves.

3. Seasonal succession: This investigation were carried out from April 1965 to April 1966. The number of adults and nymphs on each sampling place of every one leaf of 25 banana plants were counted and recorded twice a month, respectively. The plant of 1-2 m. in height were chosen for this investigation. The results were summarized in Figure 2.

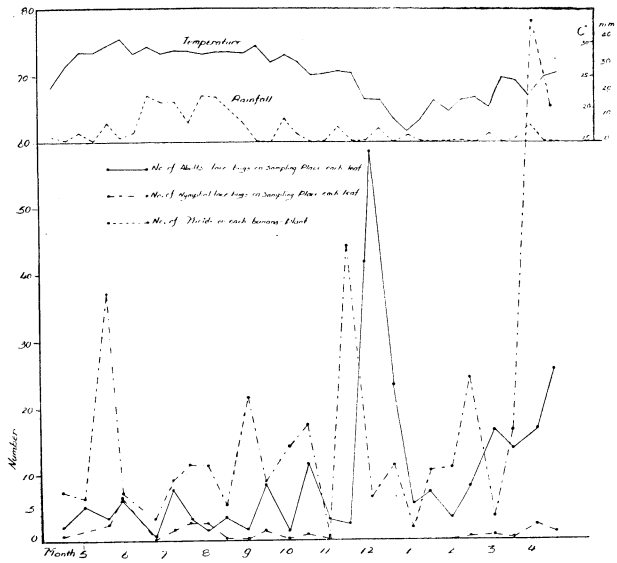

Fig. 2. Indicates a correlation between the seasonal fluctuation of lace bug and environmental conditions relative to clemate and natural enemies—*Stethocunus* sp.

According to the peak and tendency of the curve shown in Figure 2, the lace bug occured 9 generations in mid-south part of the island in a year round. The duration of the first generation began from the middle of December to the middle of February; of the second, from the end of February to the beginning of April; of the third, from the beginning of April to the beginning of May; of the fourth, from the beginning of May to the middle of June; of the fifth, from the middle of June to the middle of July; of the sixth, from the middle July to the middle of August; of the seventh, from the middle of August to the middle of September; of the eighth, from the middle of September to the middle of October; of the ninth, from the middle of October to the beginning of December. It took about 25-45 days to complete one generation in warm season, while it took about 60-75 days in cold season. All stages may be observed during the winter of that year.

The temperature at the area was favorable for the lace bug all the year round. The population density as shown in Figure 2 tended to be high during

the dry season, between September, October, November, December and the first five monthes of the next year. Rainy season seemed unfavorable for the lace bug, and was noted to have reduced the spring population and depressed a low population throughout the summer.

4. Geographic distribution: From October to December 1965 and in September 1966, the distribution of lace bug on various environment was investigated. The number of lace bugs on each sampling place of a leaf of 40 banana plants were counted and recorded. The data were shown in Table 11 which revealed that the banana plants which grew in the place of the wind-sheltered seemed to be infested more seriously than those of growing in the windswept areas. This case was particually noticeable in winter. Another inspection showed that there were no different in the population of lace bug if plants were cultured in the hillside, upland or on low land areas. In a banana orchard, generally, the population density of lace bug was higher in the side of shelter from wind than those in the sides of wind-received area.

Table 11. Geographic distribution of *Stephanitic typica*

Obs.	date	No. of Plants obs.	No. of lace-bug on the sampling place of a leaf (AV)			
			Windswept orchard	Environment	Wind-Sheltered orchare	Environment
Oct.	7	40	6.08	Up-land	10.63	Hillside
Nov.	15	40	0.86	Up-land	56.38	Up-land
Dec.	15	40	3.55	Low-land	251.88	Up-land
Dec.	16	40	30.15	Low-land	134.73	Low-land
Dec.	17	40	1.53	Hillside	141.18	Hillside

5. Preference on varieties of banana: 54 spacies of banana varieties in the orchard of Chiayi Agricultural Experiment Station were used for this study. The number of lace bugs on each sampling place of a varieties (1 to 5 plants (some varieties of banana were too high to be investigated, and some were absent)) were counted and recorded during the monthes of September, November and December in 1965. The data were shown in Table 12.

Table 12. The population density of lace bugs among 54 verieties of banana

Varieties	No. of plants obs.	Average number of lace-bugs on sampling part of a leaf				
		Sept. 15	Oct. 14	Dec. 15	Nov. 16	Total
Abaca Seedlin	3	8.36	51.12	297.00	173.00	529.48
Ai-Chueh Chiao	2	16.79	27.67	288.50	—	322.96
Ambon	3	2.34	49.47	46.00	561.50	659.31
Apple	3	1.56	7.00	2.50	474.00	485.06
Assam	3	0.63	4.14	28.00	386.00	418.77
Awak	3	1.00	21.12	73.00	45.50	140.62
Blue-Field	3	0	51.31	3.00	394.00	448.31
Boyang	2	2.23	14.69	3.00	—	19.92
Breazilian	5	0.63	25.86	24.40	28.50	79.39

Bungulan	2	0.17	7.67	3.67	275.50	287.01
Chung-Sheng-Pa Chiao	3	21.15	16.33	11.33	432.50	481.31
Cooking	2	0	2.67	112.00	5.00	119.67
Fen-Chiao	2	2.00	3.40	131.00	—	136.50
Golden-King	3	0	1.33	6.33	108.50	116.16
Golden-Beauty	3	3.49	5.86	5.67	116.00	131.02
Hsia-Li Yuan	3	31.14	43.67	26.00	352.50	453.31
Hsien-Jen Chaio	2	0	3.00	19.00	180.50	202.50
Hun-Mao Chiao	3	3.40	38.83	81.33	897.00	1020.56
Hung-Pi Chiao	2	0	7.75	18.23	26.34	52.32
Hung-Tao-Pei Chiao	3	0.80	3.23	17.67	49.00	70.70
Ice Cream	2	0.13	3.71	15.33	162.50	181.67
Idzo	3	0	3.46	2.00	5.50	10.96
Java	2	0	36.67	38.34	19.24	95.25
Kabok	2	0	20.19	1.33	200.50	222.02
Kanabu	2	0.62	22.07	32.33	251.00	306.02
Keelung-pei Chiao	1	0	39.41	16.00	182.00	237.41
Kiliang	2	2	39.20	36.00	163.23	240.43
Lacatan	2	0.86	9.92	81.43	98.26	190.47
Latundan	4	0.13	24.17	30.67	782.50	837.47
Lang-Yia Chiao	2	7.94	3.33	10.67	394.00	415.94
Lu-Sung Chiao	5	0	21.00	9.60	226.00	256.60
Malacca	1	0	22.00	2.00	85.00	109.00
Mas	3	0.33	7.57	13.33	260.50	281.73
Monkey	4	1.55	6.57	25.50	502.50	536.22
Nibak	2	0.13	2.38	73.50	218.00	293.93
Panchghol	2	2.69	13.64	34.51	83.27	134.11
Paruk	3	0.26	7.89	11.00	34.16	53.31
Peh-Chiao	2	0.11	5.64	4.67	279.00	289.42
Pendok	2	0	12.50	1.70	61.00	74.80
Pipon	3	0	11.01	171.00	221.00	403.00
Pitigo	4	0	0.83	103.67	—	104.50
Popul	2	—	—	195.00	337.00	532.00
Puerto Rice	2	0	10.00	6.67	275.50	292.17
Raja	2	1.24	5.20	7.33	559.00	572.77
Restali	2	12.44	10.38	12.50	185.00	320.32
Rilian	1	0	5.40	14.86	33.22	53.48
Saba	2	0.17	5.62	16.00	198.00	219.79
San-Chih Chiao	2	0.07	7.43	4.00	8.25	19.75
Saribu	2	8.20	9.62	27.00	47.50	92.32
Shuang-Sui Chiao	2	0	14.00	16.00	310.00	340.00
Spain	2	0.07	14.77	2.00	414.00	430.84
Su-Su	3	0	9.83	2.00	277.50	289.33
Tandok	4	0	3.75	12.00	108.00	123.75
Wei-Tsung Chiao	3	12.35	8.83	34.26	103.00	158.44

According to the data, some varieties such as Boyand, Idzo, Paruk, Rilian, Hung-Pi Chiao, San-chih Chiao and Shuang-Sui Chiao showed less injury by lace bug, and the varieties of Hung-Mao Chiao, Amban, Apple, Latundan, Monkey etc. seemed to be favourite host to the lace bug. Same observations were made by Chein & Huang (1965) at the southernpart of the island in 1964, they reported that no lace bug was found to injure the varieties of Latundan and Pipoh. However, the results of their observation disagreed with those reported in this report. Hence, it is necessary to have a further study on the field of resistance of banana to lace-bug.

NATURAL ENEMIES

During the investigations, a species of Mirid and several species of spider (Family *Salticide*) were observed to be associated with the lace bug. The later species were predacious on both of lace-bug and two-spotted spider mite (*Tetranychus urticae* Koch) on banana. The data about their biological studies were not observed here.

The Mirid which was identified as *Stethoconus* sp. was yellowish white in color with many dark-brown spotted in the body. According to the record of rearing in laboratory from March to May 1966, it took 14 to 17 days with an average of 15.13 days to complete a life-cycle at 27.03±1.63°C; while it lasted 19 to 24 days with an average of 22.13 days at 22.81±0.20°C (Table 13). It was about 8-18 days shorter in their whole development than that of the victims. The longivity of adult was 10.27 days in average, within a range of 4 to 10 days in summer. The average number of eggs laid by each female was 34, ranged 20 to 48.

Table 13. Effect of temperature on the incubation period and completed one life-cycle of *Stethoconus sp.*

Incubation period		Completed one life-cycle	
Mean Temp. (°C)	Days	Mean Temp. (°C)	Days
20.94±0.16	12.56±0.88	22.81±0.20	22.13±1.38
28.03±0.39	7.89±0.78	27.03±1.63	15.13±0.04

Both nymph and adult of Mirid were found to attack the nymph and adult of lace bug. Table 14, showed that the nymph of a Mirid destroyed 121 to 184 lace bugs (Including adult and nymph) with an average of 140.5, while in adult stage, it could prey 109 to 273 lace bugs with an average of 182.3; and therefore, a Mirid could prey some of 356 lace bugs in whole life.

Field observation indicated that the Mirid spent their winter with their egg stage. The adults of the first generation appeared in the middle of February in the area of the wind-sheltered; as to the area of the windswept, the appearance of the first generation of the Mirid would come to the beginning of April. Egg was deposited in the tissue of the leaf where the egg-mass of lace-bug was near

to. 2 or 3 of eggs were laid in a deposited site. After they hatched, the nymphs dispersed into the colonies of lace bug. Some lace bug population were quite seriously injuried by Mirid. However, Mirids caused a unevenly destribution of the population of lace bug sometimes. There were 0 to 187 mirids being found in the plant of the orchards.

Table 14. Duration of each stage of *Stathoconus sp.* and their predatory capacity

	Nymphal stage					Adult stage	Total
	1st instar	2nd instar	3rd instar	4th instar	5th instar		
Length of each instar or stage	2.06	1.38	1.50	1.75	2.88	13.14	23.28
(Days)	(2-3)*	(1-2)	(1-2)	(1-2)	(2-3)	(4-21)	(15-27)
No. of lacebugs were preyed	8.63	10.33	22.00	27.33	72.17	223.27	363.77
	(3-18)*	(5-19)	(11-32)	(14-38)	(58-100)	(109-273)	(233-396)

Note: The number in the parenthesis were shown the minimum and maximum.

SUMMARY

The observation on the ecology of banana lace bug (*Stephanitis typica* Distant) in laboratory and field during 1965 and 1966. The insect which we observed was a small bug about 0.40 mm. in length, and was a species of the family Tingidae. Both the adult and nymph of the insect injured the banana by sucking the sop of leaves under the surface, that caused the leaves to become mottled with grayish-yellow blotches and retarded the growth of plant consequently.

The result of the observation in laboratory indicated that, the bug took 9 generation in a year. The period of incubation lasted 11.92±2.43 days in summer and 32.10±10.59 in winter. The interval of nymphal stage ranged from 10 days to 38 days with an average of 17.69 days. The average number of days length of life for a female was 7.1 in summer and 36.8 in winter. The time for completing a life-cycle required 37.82 days in average, within a range of 17 days to 80 days.

The average number of the total eggs produced by one female was 36.8. The average survival rate from newly hatching nymph to adult was 69.05 per cent in field, and it reached 100 per cent if they were protected against the natural enemies. The sex ratio of adult was approximately 3:2.

Observation in field indicated that the bugs builded up some denser and larger colonies in the banana plantation where these plants were sheltered from wind than those on the wind sewpt orchard. There was no difference between the population size of the bug if the banana plants were cultured in the hillside, upland or on low land areas.

Most adults of the bug were actively on the upper part of the leaves (From

2nd to 4th leaf), and about 67.28 per cent out of the total egg-mass were found there. Nymph mainly settled on the middle part of the leaves (From the 5th to 7th leaf), about 70.37 per cent out of the total nymphs was found living on those place.

Temperature here, was favorable for the bug to propagate all the year round. The population of the bug tended to be high during the dry season, from September to May of the next year. Rainy season seemed unfavorable for the lace bug. It was noted to have reduced the spring population and depresed a low population throughout the summer. All stages might be observed during the winter.

Among 54 varieties of banana being planted in Chiayi Agricultural Experiment Station, no varieties had exactly shown resistant to the bug. The varieties such as Boyang, Idzo, Paruk, Rilian, Hung-Pi, San-chih and Shung-Sui shown less injured by lace bug.

One species of Family Miridae, *Stethocunus sp.* was found to attack both nymph and adult of lace bug. This predacious insect appeared in whole year except December and January of the next year, and they spent their winter with egg's stage. The average number of egg that was laid by each female was 34. The time for completing one life-cycle required 8-18 days. It was quicker than the victim of the insect in the same environment. A mirid could prey some of 356 lace bugs in its whole life.

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香蕉軍配蟲 (*Stephanitis typica* Distant) 之生態觀察

鄭　清　煥

中 文 摘 要

香蕉軍配蟲 (*Stephanitis typica* Distant) 爲本省近年來香蕉葉片之主要害蟲，全省各地蕉園均有分佈。其造成爲害係以成蟲及若蟲，羣集蕉葉背面吸取養液，致使被害蕉葉表面形成黃灰色之斑點，受害嚴重者，葉面整片呈蒼白狀，引起早期枯萎，終而影響蕉株之發育。

本蟲在嘉義地區，年發生九代，其完成一世代，最短須時17天；最長爲80天。在冬季除發育所歷時間較長外，並無嚴格之越冬現象，在田間各蟲期可同時發現。

按室外飼養結果：卵期在盛夏 (28.06±0.38°C) 平均爲 11.92±2.43 天，在嚴冬(17.10±0.23°C) 平均爲 32.10±0.59 天。若蟲脫皮四次共五齡，歷時 12—38天，平均爲 17.29 天。雌成蟲平均壽命：夏天爲 7.10 天，冬天爲 30.80 天。各世代各蟲期所歷時間之長短，均隨各季節氣溫之高低而不同。

由田間調查知悉，本蟲之卵成簇狀地產於蕉葉背面組織內，每一雌蟲平均卵數爲 35.80 粒，卵塊主要 (67.28%) 被產於第二片至第四片蕉葉（由上往下數）。以葉基主脈兩側10公分範圍內分佈最多。幼蟲(70.37%)（棲息於中部蕉葉第五片至第七片），其在田間之成活率平均爲69.05%，但若保護其免受天敵之侵害，則幾可這 100%。若蟲蛻變爲成蟲後，有飛往上部新葉產卵之習性，產卵時，有一隻產一處者，亦有數隻產於一處者。平時成蟲及若蟲均羣集於蕉葉背面，除非受到刺激，干擾或被害葉枯萎，甚少遷移或飛翔。成蟲之性比爲♀：♂＝3：2。

本省終年氣溫均適於香蕉軍配蟲之繁殖，棲羣密度，以乾旱季節（由九月至次年五月）較高，雨季似不適其生長。其棲羣密度在山坡地、烟地或平原水田地之蕉園，並無顯著之差異。唯其在避風蕉園之棲羣密度，往往較當風蕉園之密度高得多，在同一園蕉當中，亦以避風一方棲羣密度較當風之面爲高。

軍配蟲天敵，主要有雜食性蜘蛛類 (Family Salticidae) 及屬於盲椿象科之一種 (*Stethoconus* sp.)，前者除捕食軍配蟲外，並可捕食爲害馳蕉之二點紅蜘蛛 (*Tetranychus urtical* Koch)，後者專捕食軍配蟲，其完成一代，平均較軍配蟲快8—18天，一生可捕食軍配蟲約爲356隻左右，唯其分佈甚爲不均，對軍配蟲發生之抑制力不大。

誌謝：本試驗工作承外貿會香蕉小組補助經費，王所長茂康及陶主任家驊之鼓勵與指導及楊溫仁、賴清課兩位先生之鼎力協助。本文草成後，承蒙中興大學昆蟲系主任張教授書忱詳加斧正，感激甚深，謹誌於此，略申謝悃。